CALIFORNIA
ENERGY
COMMISSION

SCENARIO-BASED ASSESSMENT OF RESOURCE PLANS PREDICATED ON LARGE PENETRATION OF PREFERRED RESOURCES

In Support of the 2007 Integrated Energy Policy Report

STAFF DRAFT REPORT

January 2007
CEC-100-2007-002-SD

Arnold Schwarzenegger, *Governor*

CALIFORNIA ENERGY COMMISSION

Michael R. Jaske
Principal Author

Global Energy Decisions
Navigant Consulting, Inc.
Consultants

Lorraine White
2007 IEPR Project Manager

Scott W. Matthews
Deputy Director
ELECTRICITY ANALYSIS DIVISION

B.B. Blevins
Executive Director

ABSTRACT

California Energy Commission staff is conducting a scenario analysis of alternative resource plans predicated upon large penetrations of preferred resources to gain insights about how selected performance measures (reliability, cost, and environmental impacts [for example GHG emissions and water use]) might change across resource cases. Preferred resource additions are supplemented by conventional generating resources to assure reliable system operation. Quantifying scenario results allows tradeoff analyses. The resource cases span low penetration of preferred resources resulting from "current trends among key agents" toward a high penetration likely to be needed to achieve the vision of major Assembly Bill (AB) 32-like GHG emission reductions established by the California Legislature. This will focus attention on important concerns that may help to identify, if not quantify, deployment and scale-up issues. Reported project results will illustrate the challenges in achieving the vision of major reductions in GHG and identify further studies to clarify analytic issues beyond the scope of this study.

The scenarios are designed around two cases: a current conditions case reflecting recent on-the-ground actions by utilities and other load serving entities, and a second case that represents a major reliance upon energy efficiency and renewable generating technologies by 2020. A series of intermediate cases will explore the implications of each of the GHG reduction strategy elements both for California alone and then west-wide. Scenarios are also designed to satisfy a simplified version of California's resource adequacy requirements and tested to reveal reliability differences by a stochastic assessment for certain variables. Each scenario will be tested through sensitivity assessments of multiple fuel price projections, and a series of "shocks" to determine GHG emissions, total costs, emissions of standard criteria pollutants and mercury, water consumption, fuel use, and other descriptors.

KEYWORDS

Scenario analyses, resource plans, preferred resource additions, renewable generation, energy efficiency, transmission impacts, green house gases, west-wide assessments

PREFACE

As required by Senate Bill 1389 (SB 1389, Bowen and Sher, Chapter 568, Statutes of 2002), the Energy Commission conducts "assessments and forecasts of all aspects of energy industry supply, production, transportation, delivery and distribution, demand, and prices." The Energy Commission uses these assessments and forecasts to develop energy policies that conserve resources, protect the environment, ensure energy reliability, enhance the state's economy, and protect public health and safety. (PRC § 25301[a]). The Energy Commission adopts the Integrated Energy Policy Report (IEPR) every odd-numbered year and in even-numbered years adopts an energy policy review to update analysis from the previous IEPR or to raise energy issues that have emerged since the previous proceeding. (PRC § 25302[d]).

The 2007 IEPR Proceeding Scoping Order, issued on August 1, 2006, directs staff to "evaluate constraints to and opportunities for improving the state's energy system." The scenario analyses of the electricity system are key components of this evaluation.

This scenario project is a part of a series of projects that will develop a greater understanding of the actions believed necessary to achieve major reductions in greenhouse gas (GHG) emissions for the electricity sector, and the consequences of these actions. This report is specifically designed to receive public input from interested stakeholders on the proposed analyses and to consider revisions to the project design. The results of the analyses of these scenarios will be used in the development of the *2007 IEPR*.

ACKNOWLEDGEMENTS

The staff team for this project includes Mark Hesters, Mike Jaske, Ross Miller, Angela Tanghetti, and Lana Wong. Rich Lauckhart and Bryan Swann of Global Energy Decisions (Global Energy) and Ron Nichols of Navigant Consulting, Inc. have contributed considerable insight based on a wide range of previous consulting efforts. The scenario designs described in this report are a result of the collective effort of this team.

TABLE OF CONTENTS

OVERVIEW

To better evaluate energy policy issues in the 2007 Integrated Energy Policy Report (IEPR) proceeding, the California Energy Commission (Energy Commission) is undertaking a scenario-based assessment of electricity resource plans. This paper describes the rationale, methodology and proposed scenarios associated with this effort.

Assembly Bill (AB) 32, Senate Bill (SB) 1368 and the Governor's Climate Action Team efforts during 2005/06 represent a substantial signal that California takes global climate change seriously. The IEPR Committee's Scoping Order specifically identifies assessment of global climate change and mitigating policy strategies as a topic for investigation. This scenario project is designed to develop a greater understanding of the actions believed to be needed to achieve major reductions in green house gases (GHG) for the electricity sector, and the consequences of these actions. This analysis is conducted for the entire Western Interconnection (WI or west-wide) for two reasons. First, because California is pursuing mechanisms to achieve actual GHG reductions, and not simply shift the accounting attribution of GHG to another state, this analysis will examine total GHG emissions from all WI power plants. Second, the Western Governor Association resolution adopted in Sedona, Arizona in June 2006, pledges all western states to pursue GHG reduction efforts.

The scenarios are designed around two cases: a current conditions case reflecting recent on-the-ground actions by utilities and other load serving entities, and a second case reflecting an increased reliance upon energy efficiency and renewable generating technologies by 2020. The former reflects limited success in achieving state policy goals, while the latter would go beyond existing energy policy goals. A series of intermediate cases will explore the implications of each of these elements of a GHG reduction strategy for both California alone and west-wide. Scenarios are also designed to be resource adequate, but will be tested to reveal reliability differences. Each scenario will be tested in three ways: (1) with higher and lower fuel price projections; (2) by imposing a series of short-term "shocks" in natural gas prices and resource availability; and (3) in probabilistic variations around the "mean" for some key input variables. The results of these alternative assessments will be reported as differences in GHG emissions, total costs, emissions of standard criteria pollutants and mercury, water consumption, fuel use, and other descriptors.

The results of the individual scenario analyses and a comparison between scenarios are intended to allow some degree of tradeoff assessment. Some results are likely to be considered reliable enough to focus a policy discussion, while other results may require more detailed analysis using improved data and/or more extensive uncertainty assessments in subsequent projects.

Purpose

The fundamental purpose of this project is to gain insights about how selected performance measures (reliability, cost, and environmental impacts (GHG emissions, criteria pollutant emissions, mercury emissions and water use) might change across resource cases with alternative combinations of preferred resources, supplemented by conventional resources. Quantifying scenario results allows tradeoff analyses. The resource cases span low penetration of preferred resources reflecting current conditions through high penetration of these resources through AB 32 GHG emission reductions. This will focus attention on important concerns that may help to identify and quantify deployment and scale-up issues. Project results will be reported in a way that illustrates the challenges in achieving the vision of major reductions in GHG, and will point toward further studies to clarify analytic issues beyond the scope of this study.

Contributions of this study:

- The California and west-wide assessments will help to reveal transmission implications for deployments of preferred resources within and outside of California;
- Each resource case will be assessed in terms of sensitivity of performance measures to selected exogenous shocks; and
- A probabilistic analysis of the impacts of selected variables will provide an indication of reliability consequences not revealed through deterministic resource adequacy planning criteria.

Limitations of this study:

- The results will be indicative as opposed to predictive.[1]
- No assessments will be conducted for specific load serving entities (LSE) and their expected customers.
- Specific policies that might induce market participants to modify their procurement decisions to achieve a specific scenario will not be assessed.

[1] For purposes of this paper, indicative means that the results can be reliably understood in terms of the general direction and magnitude assuming certain inputs were combined as the scenario defines them. In contrast, the results are not predictive in the sense of being an accurate forecast of what will happen in the future, nor a quantification with little uncertainty of such a future.

OVERALL PROJECT APPROACH

Objectives

One objective of the analysis is to illustrate the possible consequences of a range of alternative scenarios of different built out resource plans. The proposed scenarios range from "current conditions" generation development through major reductions in GHG by pursuing large quantities of non-GHG resource options. Retirement, repowering or refurbishment of aging power plants and addressing transmission consequences of new resource development or aging plant retirements will be integrated into scenario definitions. The resource alternatives include:

- Energy efficiency/demand response.
- Renewable generation projects.
- Transmission line additions compatible with each resource scenario.
- Solar photovoltaic (PV) generation on the end-user side of the meter, i.e. rooftop units on customer buildings.

A second objective is to illustrate any differential performance of these built out resource plans for a set of exogenous events that the Western electricity grid is exposed to from time to time, such as a short-term "spike" in natural gas prices that rises and falls within a single year.

A third objective is to develop unbiased estimates of the performance characteristics of the various classes of preferred resources, so that statements about relative reliability across the scenarios are illustrative of expected system performance. Particular care will be taken to reflect these performance issues in scenarios with high system mix levels of preferred resources that are not fully assessed when additions are only "at the margin."[2]

A fourth objective is to conduct this analysis in full light of the inter-connectedness of California with the rest of the Western Interconnection (WI), which reflects imports into California from many power plant locations and also California's potential exports to

[2] Some assessments examine the consequences of replacing conventional resource additions with equal capacity of intermittent renewables, where the dispatch and locational implications of renewable generation do not imply replacement on a one for one capacity basis. Inherent limits on dispatch of some renewable resources may require supplemental additions of combustion turbines and other fast start units that can be brought on line quickly. The geographic locations of some renewable generation outside of load centers means that such resources cannot satisfy local capacity requirements (LCR) and separate capacity must be added that does satisfy LCR requirements.

other portions of the WI under their own stressed conditions. This objective emphasizes analyses showing the interactions of transmission systems capabilities and resource performance across the West.

A fifth objective is to use an integrated electricity-natural gas modeling capability to ensure that the implications of the growing convergence among these industries is assessed. The Global Energy suite of models has been selected, with supplemental analyses by Navigant Consulting using transmission models such as PSLF. Both Global Energy and Navigant Consulting have been engaged for this project.

A sixth objective is to ensure reasonable internal consistency in establishing the characteristics of each scenario.

A seventh objective is to improve understanding of the limitations of data and modeling capabilities to achieve these objectives in either an illustrative or conditionally predictive[3] manner, and to make recommendations for future improvements to reduce or eliminate these limitations.

Summary of the Analytic Approach

The objectives for reliability assessment and integrated assessment between electricity and natural gas sectors caused staff to select the Global suite of production cost, natural gas supply, and generation expansion models supplemented by power flow assessments to develop needed transmission additions and assess reliability.

Scenarios will be constructed to satisfy normal resource adequacy standards, such as those that exist for all of the WI through Western Electricity Coordinating Council (WECC), or can be extrapolated from regional decisions. For this project that means effort to understand capacity values[4] of resources using conventions adopted by the California Public Utilities Commission (CPUC) for resource adequacy purposes.[5] The

---

[3] In contrast to fn. 1, conditionally predictive results would be considered accurate representations of key results into the future assuming one or more key input assumptions actually happens as described in the analysis. Given current understanding of this variable or variables, it may be impossible to predict with any accuracy whether this or some other condition will happen in the real world.

[4] The form of resource adequacy adopted by the CPUC uses a 15 percent planning reserve margin calculated as capacity of generating resources in excess of expected monthly peak demand. A series of formulas define how much capacity each resource type is allowed to count in satisfy resource adequacy requirements.

[5] The CPUC has adopted a body of resource adequacy requirements for all LSEs within the California Independent System Operator (ISO) control area. These specify a monthly planning

Northwest Power and Conservation Council (NWPCC) is adopting guidelines for Northwest utilities. [6] Since WECC also is developing its own metrics and guidelines for resource adequacy, this project must necessarily devise a hypothetical "requirement" for those portions of the West without formal standards.

Three forms of analysis will be conducted: (1) deterministic assessments of each scenario evaluated with several alternative fuel price projections, (2) sensitivity assessment of each scenario to each of three "disruptions" to normal conditions, and (3) stochastic assessment exploring through Monte Carlo runs the consequences of varying several key input values that have known probability distributions.

Deterministic Assessment

Each scenario will be evaluated using Global's production cost model run for the study period from 2007 through 2020 for the entire WI, in a mean value, deterministic manner for each of several alternative fuel price trajectories through time. In this Version 3-7 of the project description, the number and characteristics of fuel price scenarios have not yet been determined. Supplemental analyses of transmission will use the Positive Sequence Load Flow (PSLF) model to address contingencies.

Sensitivity Assessments

Scenarios will be tested for vulnerability to shocks using sensitivity cases. These sensitivities illustrate stress to the electric system that would last about one year, causing either physical shortages or financial consequences. Since little or nothing could be done to replace the lost capacity or energy that would normally be available, while equipment was being repaired, these sensitivities reveal a degree of resilience[7] that may differ across the scenarios. The single year of 2015 will be assessed, which is far enough into the future to allow the difference in resource mix to emerge, but close enough in time that the system is still dominated by the current set of resources. **Illustrative** sensitivities include:

- Generation and transmission facility failure resulting from a Southern California earthquake.

---

reserve margin of 15 percent above 1:2 monthly peak demand. They also specify capacity counting conventions that determine the capacity value of resources in each month.

[6] NWPCC has initially focused on development of resource adequacy standards for the Northwest that focus on the energy adequacy concerns of the PNW during adverse water conditions. A proposed capacity metric and guideline is now under review.

[7] For this paper, resilience is defined to mean the ability to satisfy reliability requirements not only under expected conditions, but also in adverse conditions tested in the sensitivity.

- Drought-induced low hydro-electric generation along the West Coast.
- A natural gas price spike lasting about one year replicating Gulf Coast natural gas production disruptions occurring as a result of major hurricanes in the Gulf of Mexico.

Stochastic Assessment

Each scenario will also be assessed for reliability by running the Global Energy production cost models in a stochastic manner[8] for key variables the single year of 2015, which is designed to illustrate reliability concerns. The scope of variables treated in a stochastic manner should include peak load, expected plant performance under peak conditions, power plant forced outages, transmission outages, and fuel prices. Some external assessment of inter-transmission bubble transfer capability and vulnerability to specific transmission line outages will be assessed offline and inserted by assumption into the Global Energy models for these stochastic analyses.

Evaluation of Scenarios and Sensitivities

Scenarios will be developed into west-wide production cost datasets evaluated using Global Energy's MultiSym production cost model. Each of these will be run on an hourly basis for 2007 to 2020 and a variety of summary statistics saved in a Microsoft Access® database. As noted above, while the deterministic assessment will be examined for all years, the sensitivity cases and stochastic assessments will be conducted for year 2015 alone.

The project will generate scenario characteristics by measuring the following scenario attributes:

- Power plant emissions of GHGs.
- Water use.
- Electricity operating costs.
- Incremental electricity capital costs by technology.
- Electricity production by technology.
- Fuel use.
- Emissions of criteria pollutants (selected pollutants such as NOx, SOx), and the toxic chemical mercury.

[8] Stochastic means a variable that moves along a central tendency, but with variation around this central tendency following a known probability distribution.

- Water usage for electric generation.
- Reliability impacts (selected sensitivity case and stochastic re-assessment results).

The modeling results will consist of directly modeled values captured in a database recording direct model outputs and indirectly modeled values computed for some variables by post-processing of direct modeling results to construct other variables of interest. (For example, GHG release will be computed through fuel use by fuel type multiplied by GHG emission factors appropriate to each fuel type.)

Evaluation will begin by comparing one scenario to another to discern implications of the thematic differences between related scenarios using the attributes captured from the model runs or computed from modeling variables. This involves a limited form of tradeoff analysis, although falling well short of the formal evaluation of tradeoffs relative to an efficient frontier. Total scenario costs, with capital requirements considered on a life cycle basis, will allow examination of any impacts on economic growth.[9] However, in-depth examination of economic impacts of cost differentials is beyond the scope of this project.

Evaluation criteria consist of the following items:

- GHG level.
- Total cost.
- Adverse consequences from system shock sensitivities.
- Reliability threats from stochastic re-assessments.

[9] To ascertain whether total scenario costs could impact economic growth, some broad measures of average electricity rates or typical electricity bills should be prepared and reported for each scenario and sensitivity case. Staff is investigating its ability to perform such work in the timeframe of this project.

SCENARIO DEVELOPMENT AND MODELING PLAN

Broad Scenario Development

The project budget supports development and assessment of nine scenarios reflecting different system mixes of the preferred and conventional resources (plus appropriate transmission) that are internally consistent.

The two "bookend" scenarios are intended to provide the bounds on a series of intermediate cases:

- One bookend reflects limited success in achieving policy goals, because of potential cost, jurisdictional, and resource availability issues; and
- The other bookend assumes major penetrations of preferred resources beyond current energy policies, but which are considered "achievable" from a technological and total cost perspective.

A series of intermediate scenarios reveals the contribution of individual preferred resource types such as efficiency or demand response (DR), renewables, end-user solar PV, necessary transmission lines to support the generation resource mix and retirements of aging power plants. Most alternative scenarios are designed in two versions: (1) just for California with the rest of the West using current trends assumptions, and (2) broad deployment of the featured resource across the entire WI. These intermediate cases will help to explain the differences between the bookend cases and separate out the influences of specific elements that are different between the two bookends.

Staff and consultant team has prepared proposed scenarios and sensitivity cases over the initial period of the project. Staff has consulted with the IEPR Committee and with some stakeholders on an informal basis to review these cases and the results that might be gleaned from them.[10] Table 1 provides an initial characterization of such scenarios for illustrative **discussion only**. The general theme, source materials if these exist, and some estimate of the difficulty of development have been identified. No final commitment to all of these specific scenarios has yet been made. Stakeholder discussions and a public workshop will help to determine the final scenario themes. To the extent that comment at the workshop suggests a revision to a proposed scenario or addition of further scenarios, some limited adaptation is feasible within the current budget scope and schedule. More elaborate revisions would at least lead to a delay in release of results.

---

[10] Attachment A provides a brief summary of the discussions with stakeholders conducted in advance of the release of this report.

Energy efficiency represents an obvious option to reduce GHG emissions. California has pursued end-user energy efficiency for more than three decades through appliance and building standards and through retrofit energy efficiency programs. Even though billions have been spent in reducing California's electricity usage per unit of gross domestic product to be among the lowest in the United States, energy efficiency potential studies indicate that still more is cost-effective.

Renewable generation technologies (wind, geothermal, central station solar, biomass, and so forth as illustrations) represent another obvious option to reduce GHG emissions. Again California has a significant baseline resource mix of renewable resources and strong policies aimed at increasing the portion of these resources in the generation mix. Significant additional renewable development potential exists.

The west-wide variations of key scenarios makes use of the results of an extensive dialogue among western policy makers and energy decision-makers about the role of renewable generation and end-user energy efficiency in the West. [11]

For this study, no improvements in preferred technology cost or performance will be assumed through time.[12] To do so requires additional expertise that is not available to the project and that is inherently speculative. Optimistically, one could assume that wind turbine performance improves and that capacity factors under low wind conditions diminishes some of the need for firming capacity through combustion turbines (CT) or other dispatchable, low annual capacity factor technologies. Pessimistically, one could assume that central station solar performed well initially, but solar unit performance degraded faster than expected, effectively requiring replacement capacity and increasing total costs. Capital costs and energy generated by technology can be tracked to determine the degree to which overall system performance is exposed to such unknown uncertainties. Side analyses of higher or lower values could serve as a gross indicator of sensitivity to alternative assumptions.

Attachment C provides a working version of the major assumptions containing the level of detail needed for developing scenario input datasets. A spreadsheet version of Attachment C is also available.

---

[11] The Clean and Diversified Energy Assessment Consortium (CDEAC) developed a large body of recommendations for achieving a broad target established by the Western governors. The CDEAC work presents a starting point for broad, aggressive penetrations of energy efficiency measures and renewable generation. [http://www.westgov.org/wga/initiatives/cdeac/cdeac-reports.htm#TaskForceReports]

[12] The California Solar Initiative, a vision of 3,000 MW of rooftop photovoltaic panels, is directly predicated upon volumetric production-induced reductions in cost per MW of capacity. In scenarios with this technology, the general approach of assuming fixed cost technologies will be violated.

Detailed Design of Scenarios

Energy Commission staff has limited capabilities to cover the wide range of inputs required to generate these scenarios, requiring other Energy Commission program staff, contractors, and existing studies to be major sources of necessary information. This section provides an overview of staff contacts and other sources of information that have been important in developing input assumptions. Attachment A documents contacts with stakeholders that have been made to inquire of related projects or scenario design comments.

TABLE 1 – INITIAL MOCKUP OF SCENARIO DEFINITIONS

Scenario Name	Thematic Characteristics	Fuel Price Trajectory	Possible Source/Starting Point
1A. Current Conditions	Utility resource addition practices guided by, but failing to fully achieve resource preferences of Western regulators	A range of projections	Global Energy, Navigant, or SSGWI base cases, or some amalgam of all three
1B. Current Conditions Assuming Preferred Resource Additions	For California, the most recent information about likely compliance with preferred resource addition policies; while for the rest of WECC state policy compliance will be assumed	Moderate only	Case 1A; LSE 2007 IEPR submittals replacing some assumptions of Case 1A; RPS policies of other western states
2. Current Conditions with Very High Fuel Prices	Same as Case 1 with resource plans built with expectation of very high fuel prices	Very high fuel prices only	Initial years are Current Trends, then diverges somewhat
3A. High Energy Efficiency/PRD in California	Current Conditions with high levels of energy efficiency and price responsive demand located only in California	A range of projections	Current Trends case with CPUC EE potential study of technically feasible
3B. High Energy Efficiency/PRD in WECC	Current Conditions with high levels of energy efficiency and price responsive demand throughout the WI	A range of projections	Case 4A for California bubbles and CDEAC for rest of WECC

Scenario Name	Thematic Characteristics	Fuel Price Trajectory	Possible Source/Starting Point
4A. High Instate Renewables Plus Transmission	Current Conditions with high levels of renewables located only in California supplemented by dispatchable resources to meet reliability and appropriate transmission	A range of projections	PIER Intermittancy Assessment Project; California ISO study of three southern California transmission lines or others; California Solar Initiative
4B. High Western Renewables Plus Transmission	High levels of renewables throughout the WI serving both California and other utility loads	A range of projections	A blend of Case 4A and some of the CDEAC Renewables Task force results and other state end-user PV efforts
5. West-wide Maximum Preference	Highest feasible levels of EE, renewables, etc. on a west-wide basis along with necessary transmission	A range of projections	Draws upon CDEAC (May 2006) Task Force recommendations
6A. Aging Power Plant Retirements with Conventional Repowering	Broad replacement of fleet of aging power plants, and where LCR and zonal analysis suggests capacity required it is conventional resources	A range of projections	Case 1A, plus results of Navigant analysis of aging power plants replaced in LCR load pockets, and others by out of state resource additions because transmission system upgrades creates more locational flexibility
6B. Aging Power Plant Retirements with Renewable Replacement	Broad replacement of fleet of aging power plants with renewable capacity where feasible and with dispatchable gas fired elsewhere	A range of projections	Case 6A, with differential emphasis toward renewable replacement of capacity and some dispatchible firming capacity in load pockets

Energy Efficiency/Demand Response

Energy efficiency and demand response (EE/DR) have been proposed as an explicit theme of two scenarios. This requires estimates of a range of feasible load reductions, the cost in segments along this range, their impacts on load shapes, both within California and for the whole West.

As a result of the initial discussions with the Energy Commission Demand Analysis Office, the original work authorization with Navigant Consulting was augmented to add energy efficiency expertise to the project. The 2004 technical potential study, prepared and released by Itron in 2006, is the best readily available source for this information at this time. Navigant Consulting resources will be used to adapt existing techniques previously used by Navigant to model energy savings by measure as hourly load shape modifiers in the Global Energy production cost model. Demand Response assumptions will also be crafted from extrapolations of existing programs scaled to achieve policy goals established in the agency policy processes.

A Lawrence Berkeley National Laboratory study reviews the incorporation of energy efficiency in the integrated resources plans of western utilities. The CDEAC study addresses a major penetration of energy efficiency, again on a west-wide basis. Neither of these studies report information at the level of detail needed to construct datasets, although they may be useful in distinguishing among broad potential and program impacts already included within utility IRPs.

Distributed Generation

The state's Energy Action Plan II adds distributed generation/combined heat and power (DG/CHP) to the preferred resource additions in the Loading Order, but no numeric goals have yet been established.

Limited resources are available to develop the assumptions needed for addressing the DG/CHP subjects in these scenarios. Including the impacts of California Solar Initiative (CSI) is likely to be the only DG element addressed. Since the CSI (and its limited counterparts in other states) is likely to be reflected on the customer-side of the meter, the impacts of PV production will be a modification to the load shape to which generating resources are scheduled and dispatched.

The National Renewable Energy Laboratory (NREL) has identified some datasets that may be useful in the stochastic analysis by merging predicted performance with hourly weather data to observe differential output as clouds or degrees of cloud cover reduce solar insolation received by the PV mechanism.

Renewable Generation

Renewable generation will be a prominent feature of some of the scenarios evaluated in this study. Both instate and west-wide development will be investigated. The May 2006 Renewable Task Force report of the CDEAC study provides both the basis for a substantial penetration of renewables around the West, plus makes an initial attempt to assess the transmission development requirements to support this set of generating technologies.

An Energy Commission's Public Interest Energy Research (PIER) project known as the Intermittency Analysis Project (IAP) is clearly examining some of the same technical issues of wind performance and the insights gained to date should be used in developing the Global Energy datasets for the High Instate Renewables case to the extent feasible. The IAP project has also developed an extensive stakeholder profess, which might provide an audience for a "higher" level, but still related project. Substantial efforts are being undertaken to make use of the assumptions, and perhaps some of the results, of the IAP effort for scenario 4A (high California renewables development).

The Energy Commission Electricity Analysis Office has processed historic California Qualifying Facility (QF) performance data (2003-2005) for wind and small hydro, and this information can be used to provide the basis for firming capacity needed to satisfy CPUC/California ISO resource adequacy requirements and perhaps to form the basis for the stochastic performance of generating resources that is desired for this project to test reliability.[13]

NREL has been consulted concerning technology cost and performance data for several renewable technologies. Hourly wind production data for a single year has been distributed broadly by the NREL and this can be a source to develop average and stochastic performance data for non-California wind regions.

---

[13] This confidential data was acquired from the CPUC, the terms and conditions of the resource adequacy protective order dated June 10, 2006, and an interagency agreement between the Energy Commission and CPUC. While the PO allows the Energy Commission to use these data outside of the resource adequacy proceeding, the Energy Commission must ensure that only aggregates are published and that these cannot reveal the underlying confidential data.

Transmission

Transmission will play a substantial role in this project from two perspectives. First, instate transmission upgrades are expected to be required to retire aging power plants without repowering in place. Local capacity requirements established as part of the CPUC/California ISO resource adequacy process provide the foundation for determining supply adequacy needs. Renewable generation development, either in-state or out of state, requires transmission to move power to load centers.

The PIER-funded IAP project is examining transmission requirements from the locational development of renewable generation. While powerflow case datasets are confidential according to the non-disclosure agreements negotiated for the IAP project, more aggregated descriptions of transmission line additions are not confidential. Such IAP results for transmission additions will be acquired and reviewed for use in this scenario project.

Navigant consulting is undertaking a special assessment of the retirement of aging power plants and their replacement by either new generation or transmission system upgrades. This effort is closely related to an ongoing Energy Commission staff/California ISO transmission planning project that has made slower progress than hoped for.

Preparation of Scenario Datasets

Two different versions of dataset will be prepared for each scenario: (1) the deterministic datasets used to evaluate the basic scenario itself and the alternative fuel price sensitivities, and (2) two forms of specialized datasets for year 2015 that test: (a) the sensitivity shocks to evaluate resilience, and (b) the stochastic variations needed to evaluate reliability.

Resource Adequacy for Each Scenario

The scenarios have so far been described in terms of the “theme” around which each is organized. In addition, each scenario will be built to satisfy a simplified version of the CPUC’s resource adequacy requirements to assure that reliability standards are observed when the dataset is run. This requires two decisions: what to assume about planning reserve margins out into the future, and whether to presume that the CPUC‘s version of resource adequacy, for example, capacity adequacy, is appropriate in each scenario.

Lacking specific evidence to the contrary, the 15 percent planning reserve margin was extended out for the entire time horizon of the analysis. Since the analysis is being conducted on a physical basis, the LSE-specific element of CPUC requirements was essentially converted into a physical system requirement. WECC itself has been examining such variants of resource adequacy in its recent Power Supply Assessment reports.[14] However, the WECC assessments are focused on developing a portrayal of the need for resource additions to satisfy an adequacy guideline, while the effort of this project is to add generic resources of various types to satisfy the resource adequacy guideline.

While California was the first jurisdiction to create a formal resource adequacy requirement, the Northwest is in the midst of its own effort. Further, even though the PNW has developed an energy-based resource adequacy guideline, it too recognizes the need for a capacity-based guideline.

Thus a 15 percent planning reserve margin based on monthly peaks, using the resource counting rules established by the CPUC, was imposed on the entire WI for each scenario. Where the resources added under the thematic elements of the scenario were insufficient to satisfy such a requirement, dispatchable combustion turbines were added.

Basic Deterministic Datasets

Scenario datasets suitable for use with the Global Energy suite of models will begin preparation with the "current trends" case since it is closest to existing production cost datasets already developed for other projects. The less complex cases such as "current trends" with extremely high fuel prices or high energy efficiency are likely to be prepared next. The high renewables scenario and the composite energy efficiency and renewables scenario will likely come last.

Some intermediate case datasets will be prepared before the scenario workshop, while others will not be commenced until the workshop input has been received. Project resources will be conserved by finalizing labor-intensive datasets with the input of workshop participants as opposed to being revised following possibly useful insights from participants.

A variation of the "current conditions" scenario reflecting California LSE resource choice decisions, and something close to compliance with various RPS requirements for non-California entities, may be developed from the inputs received from those

[14] WECC, 2006 Power Supply Assessment. See www.wecc.biz

LSEs submitting demand forecasts and resource plans pursuant to 2007 IEPR Forms and Instructions. Since these inputs will not be received until approximately February 1, this case will be among the last ones developed.[15] Even though not all LSEs will be asked to develop and submit built out resource plans, the LSEs will provide useful incremental scenario definition and their own collective load forecasts that can be a useful complement to other scenarios built largely from the low penetration bookend scenario.

Supplemental Datasets for Sensitivity Assessments

The medium fuel price case of each scenario will be rerun for year 2015 to evaluate the resilience of the system to sensitivity shocks.

The purpose of sensitivity "shocks" for this project is to determine the resilience of the system to reduction in available capacity or sudden increases in fuel prices. All of the proposed "shocks" are understood in the industry, could come in any year, and the issue is whether the base scenario can perform adequately in the face of the illustrative sensitivity shocks that have been identified at this time are:

- Generation and transmission facility failure resulting from a Southern California earthquake.
- Drought-induced low hydro-electric generation along the West Coast.
- A natural gas price spike lasting about one year replicating Gulf Coast natural gas production disruptions occurring as a result of major hurricanes in the Gulf of Mexico.

Each of these requires adjustments to the basic dataset or key assumptions for year 2015, and then a rerun of the model. Comparing the results of the sensitivity cases with the basic model run identifies the impacts on results.

Supplemental Datasets for Stochastic Assessments

The medium fuel price case of each scenario will be rerun for year 2015 to ascertain the stochastic variation of the results from a series of key inputs with known probability distributions.

[15] The resource choice decisions of the three large California IOUs documented in the mid-December filings these entities will make to the CPUC as part of the Long-Term Procurement Proceeding (LTPP).

The purpose of the stochastic assessments for this project are to explore the variations in several key variables that have sufficiently well understood probability distributions that one can set up and test the consequences of random “draws” in values as the model executes its simulation from one day to the next. The base deterministic assessments have run the average, mean, or typical value of the variable, so this supplemental stochastic assessment is intended to explore the performance of the system within a range of values. A preliminary set of stochastic variables includes:

- System load,
- Plant performance (limited to certain renewable technologies with no backup, and for wind the performance pattern will be linked to demand if the load selected represents a peak condition),
- Hydro-electric generation,
- Power plant forced outages, and
- Fuel prices.

For example, wind performance patterns for the deterministic runs are the average or mean of typical hourly production pattern recorded from wind generators in each wind zone. Such averages are made up of wide variations in patterns from day to day. Global Energy has devised a method of selecting a chronological hourly production profile that seeks to replicate the variation in wind patterns in the real world. As wind patterns within the day or from day to day differ, then other generating resources will have to be run more or less to correspond. Across a year, the expectation of a series of stochastic runs is that the wind energy would be the same as in the deterministic case with an average generating profile, but the stochastic case may reveal the need for additional dispatchable capacity to assure system reliability.

Scenario Assessments, Supplemental Calculations and Model Runs

Consultants and staff will collectively prepare the bookend and intermediate scenario, alternative fuel price cases, and sensitivities. A nominal schedule reflecting staged development of the cases and running the results is appended as Attachment B. The scenario analysis is expected to be conducted using the following groupings:

- The first group consists of scenarios 1A, 2.
- The second group consists of scenarios 3A, 3B, 6A, 6B.
- The third group consists of scenarios 1B, 4A, 4B, 5.

Two assessment techniques will be used iteratively to assess the scenarios: production cost modeling and transmission load flow.

Production Cost Assessments

Global Energy's production cost model will be run with an initial version of each scenario's dataset to verify that the model is running properly and that the results are reasonable. The moderate fuel price projections will be used for this dataset validation. Once initial screens for production cost modeling are satisfied, the results will be passed to Navigant Consulting for load flow assessments.

Staff plans to assess each scenario using a range of fuel price projections developed by Global Energy.[16]

Transmission Assessments Using Power Flow Models

Side analyses by Navigant Consulting to explore aging power plant retirement implications and other transmission requirements for selected scenarios will be conducted in a manner that presages the use of this information in developing the Global Energy production cost model datasets. Navigant's effort will focus upon the needs of the zonal version of the Global Energy models, for example capacity located by "bubble" and transfer capability changes between "bubbles."[17]

In addition, once the initial test results for each scenario have been completed with the production cost model, Navigant will use power flow modeling to assess whether the basic model datasets satisfy resource adequacy criteria.

Finally, once the stochastic results have been completed, Navigant will also verify that reliability criteria are being respected and, if not, propose tweaks to the datasets to the original datasets.

---

[16] Global Energy is updating the 2006 natural gas price projections previously made available to its Advisory Service clients.

[17] The California ISO transmission planning staff and the Energy Commission staff are undertaking a more detailed analysis of the aging power plant retirement policy established in the 2005 IEPR.

Modeling of Natural Gas Price Implications of Scenarios

Compared to the "current trends" scenario, some of the scenarios for this project are expected to result in major reductions of power plant use of natural gas for electric generation (UEG). Previous studies have found such UEG reductions reduce the price of natural gas, although these studies acknowledge the uncertainties of their results due to the limited modeling capabilities that were used.[18] One of the attractions of the Global Energy Suite of models is the integration of a production cost model of electric generation with a natural gas system model that can test the gas price consequences of lower UEG usage.

For the High Renewables West-wide scenario (Case 4B) or the West-wide Maximum Penetration (Case 5), staff proposes to run Global Energy's natural gas model with the lower UEG demands resulting from decreased electrical generation by fossil fuels to determine the extent to which natural gas prices are reduced by lower UEG demand. Since the impacts of these scenarios will be most pronounced in the later years of the simulation, how this anticipated change interacts with independent natural gas system changes to produce market prices cannot be readily anticipated; thus explicit modeling is proposed.

Reporting of Results

The results of the scenario project will be reported in two reports.

- This scenario description report facilitates input at the scenario definition stage of the project.
- A scenario results report (staff lead, Global Energy/Navigant support) will provide a written description of the results of assessing the scenarios using the chosen attributes to be reported. The scenario description itself will be written as each scenario is chosen. The results/output will be added as available. Global Energy will assist staff in extracting the model output. Navigant will contribute its results and specialized assessments. Sections of the results report will document specific categories of inputs and side assessments that necessitate special consideration. A final section will address limitations and caveats necessary in understanding how the results may be used.

---

[18] Martin, Jennifer, Center for Resource Solutions, *Cost and Rate Impact of a 33 Percent RPS*, CPUC workshop held November 17, 2005.

Staff will be keeping track of advantages/disadvantages of this analytic process and recommendations for long-term, strategic analytic improvements that require improved modeling capabilities, more extensive data, or both. This may be useful in structuring future efforts.

Model results will be stored in a database for later retrieval and analysis in the scenario comparison stage of the project. Some attributes of scenarios are directly modeling results from the Global Energy suite of models, while other variables can be computed from these direct results using "factors" such as tons of GHG/mmBtu of natural gas burned, tons of GHG/mmBtu of bituminous coal burned, etc.

The voluminous simulation results and the large number of transmission areas for which the zonal version of the production cost model are being run make reporting the results a major challenge. Four distinct tabulations are currently planned for the Scenarios Results Report. These are:

- Core results for each scenario and fuel price projection case for California and west-wide for nearly all physical and financial variables;
- Basic energy generated, fuel consumed, criteria pollutant emissions and mercury released, and water consumption I power generation for each transmission area;
- Sensitivity case results for 2015 for each scenario and fuel price projection case for the California and west-wide; and
- West-wide stochastic results for each scenario (medium fuel price case only) for operating costs, fuel consumed by powerplants, expected unserved energy, and loss of load probability.

The input datasets, and the portion of final results reposing in the Microsoft Access® database will be available to guide further examinations than those documented in the report itself.

FRAMING POLICY QUESTIONS FOR 2007 IEPR PROCEEDING

Staff expects that the scenario assessment results will provide insights into the consequences of these scenarios and uncover, or perhaps quantify in a more detailed manner than previously available, issues about high penetrations of preferred resource additions. Staff intends to identify these insights and issues through the main results report and to suggest which ones merit public discussion in IEPR workshops and hearings. It is possible that only a portion of the results will lead to insights that are considered sufficiently firm that a direct policy discussion is appropriate in this IEPR proceeding. Other aspects of the scenarios may be inconclusive given the data and modeling tools employed. No public policy debate would be appropriate in such instances; rather, indicative results might require further analysis using more finely crafted scenarios, improved data, different modeling tools, and so forth. Such results could simply lead to further analytic investigation if resources were made available.

The scope and schedule for any discussions and debate concerning energy policy issues meriting immediate application have not yet been determined, but to fit within the 2007 IEPR schedule, these would have to take place in June – August, 2007 time period.

ATTACHMENT A: VETTING PROJECT WITH EXTERNAL STAKEHOLDERS[19]

A limited number of stakeholders were provided an early draft of this report.

California ISO – initial discussions explaining this project, and its relationship with a pre-existing aging power plant retirement project were held on two separate instances with California ISO Northern California Transmission Planning staff. The California ISO is interested in some form of participation in this project to review the transmissions additions assumed for each scenario. The California ISO itself has previously proposed to conduct long-term generation development scenarios, but has not yet commenced a formal project.[20]

WECC Transmission Planning Stakeholders --The WECC Transmission Expansion Policy Planning Committee (TEPPC), its advisory committee, the Technical Advisory Committee (TAS), and one or more of the following TAS Work Groups (data, models, studies) are likely to be interested stakeholders. This newly formed group at WECC is developing its own processes and mechanisms to examine transmission planning coorination issues across the interconnection. In addition to TEPPC itself, members of TAS or the work groups are quite knowledgeable of or participated in the CDEAC study and the western congestion study. By contacting TEPPC to solicit feedback, a broad range of views may be elicited. In initial discussions with TEPPC members. As a result, staff has learned that TEPPC itself will be working on a western scenarios assessment project in this year, and TEPPC may be able to build upon this Energy Commission effort.

Renewables experts – Given the prominent position that renewable generation will receive in this project, some discussion with renewable generation experts should be conducted. Various National Renewable Energy Laboratory experts have been sources of data and assistance in the early stages of this project. In addition, the extensive IAD project suggests that a community interested in the issues of wind integration already exists that may be interested in this project and its results.

Environmental Advocates – Given the interest of Natural Resources Defense Council (NRDC) in global climate change, NRDC was provided an early draft of this report to facilitate discussion of the project. No comments were received.

CPUC – CPUC/Energy Division staff assigned to procurement may be interested in this study as a backdrop to their efforts to guide IOUs toward achievement of state preferred

[19] Information current as of January 16, 2007.

[20] California ISO, Draft 2006 Transmission Plan, Section 8, December 2006.

resource goals. CPUC/Strategic Planning staff may also be interested given their assignment to address IOU global climate change activities. Early drafts of this report were provided to representatives of both groups within the CPUC staff. No substantive concerns were raised in initial feedback.

IOU Resource Planning and Procurement Staff– Given the potential for overlap with the existing Long-Term Procurement Plan (LTPP) proceeding at the CPUC, some discussion with representatives of the three IOU resource planning staff is appropriate. An advance copy of this report was provided to SDG&E for review, and some limited comments were received.

ATTACHMENT B: DRAFT SCENARIO PROJECT SCHEDULE

November 1, 2006	IEPR Committee approval for project
Nov. 7-December 15	Meet with internal Energy Commission staff groups and discuss project participation and expectations
December 15	Finalize preliminary scenario descriptions
Dec. 15-January 12	Talk with stakeholders
Dec. 21	Brief IEPR Committee
Dec. 22	Review preliminary current trends results, if needed, finalize current trends dataset
Jan 8 – Jan 26, 2007	Model 1st group of scenarios and sensitivity cases
	rollout of results to reviewers and modify if necessary
	Review revised scenario results
Mid-January	Prepare and issue scenario description report
Late January	Workshop presenting scenarios to stakeholders and eliciting feedback
Mid-February	Finalize scenario definitions based on workshop
Feb 5 – Feb 23	Model 2nd group of scenarios sensitivity cases
	Rollout of results to reviewers and modify if necessary
	Review revised scenario results
Mar 5 – Mar 23	Model 3rd group of scenarios and sensitivity cases
	Rollout of results to reviewers and modify if necessary
	Review revised scenario results
March - May	Prepare scenario results report
Early to mid-June	Finalize and distribute results report
June - Aug	Policy review workshops (as warranted)

ATTACHMENT C: ALTERNATIVE RESOURCE PORTFOLIO CASES

Alternative Resource Portfolio Cases (note Additional Cases 7a and b to be added for aged generation retirements and transmission additions cases)

Scenario Componen, Factor, Assumption	**Case 1**	**Case 1 b**	**Case 2**	**Case 3a**	**Case 3b**	**Case 4a**	**Case 4b**	**Case 5**	**Case 6a/b**
Characterization of Case	**Current Conditions -**	**Modified Current Conditions Case to Reflect Renewable Additions the California LSEs Propose to the CEC in Upcoming Proceeding and Assume Other WECC States Meet Respective Current RPS Goals**	**Current Conditions & "Super High" Gas Prices (*Note: this case will get reviewed further after gas forecast assumptions are developed by separate team)***	**High Energy Efficiency and Variable Demand Reduction in Calif Only (Case 1 Mod by EE and VRD)**	**High Energy Efficiency and Variable Demand Response Westwide**	**High Renewables in California (in-state installation) w/ required associated transmission additions**	**High Westwide Renewables w/ required associated transmission additions (do not limit CA renewables to in-state only)**	**Westwide Maximized Preferred Resources (Energy Efficiency and Renewables - Combination of Case 3b and 4b assumptions)**	**Accelerated Retirement/replacement of Aged Generation (Note, a case 6b may be developed if the aged generation that is retired is deemed able to be replaced w/ a meaningful amount of renewable resources in constrained load pockets)**
Peak Load & Energy Forecasts									
Load Forecast	Use Global Energy's WECC forecast and the CEC staff's June 2006 forecast for California	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions
Energy Efficiency and Variable Demand Reduction Programs									
Energy Efficiency - California	The CPUC's 2006 to 2008 commtted energy efficiency programs are reflected in the CEC staff's 2006 CA load forecast. The assumed savings will be identified to note the level of energy and peak reduction attibuted in the forecast. No further changes beyond 2008 (assume 2008 levels of savings continue)	Adjust only if LSE input to CEC reflects greater savings	Assume Case 1 levels through 2009 and then ramp up to Case 3a levels by 2013 and beyond - assuming price effects motivate customer reaction to higher EE.	Use Itron 2006 study results as source of energy efficiency measures for 2006-08 and then adjust the forward forecast for those measure effects. Assume CPUC's plan for EE is met 2008 through 2013, and then after 2013 EE spending increases to $750 million annually, w/ load savings increase proportionate to spending (essentially GWh sales staying flat). Assume muni utilities pursue same path as IOUs, but with a 3 yr lag and achieve ~75% of IOU level	Use Case 3 a assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 3a assumptions	Use Case 1b assumptions
Energy Efficiency - Rest of WECC	Assume no incremental EE programs	Use Case 1 Assumptions	Assume rest of WECC achieves capita reductions equal to 50% of California.	Review LBL study on E.E. proposed in WECC State IRPs and use those assumptions as applicable, For states w/ no such information, use Case 1 assumptions	Assume 20% reduction in Case 1 load forecast through new energy efficiency programs in WECC by 2020 - assume level annual ramp from 2008 to the 2020 goal.	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 3 b assumptions	Use Case 1 assumptions
Variable Demand Reduction Programs - California	Assume only the current committed levels of variable demand reduction, and that those levels continue for the duration of the assessment period	Use Case 1 Assumptions	Assume Case 1 levels through 2009 and then ramp up to Case 3a levels by 2013 and beyond - assuming price effects motivate customer reaction to higher EE.	Assume IOUs achieve the 5% of peak demand response by 2013 with linear annual ramp up additions 2007 to 2013, and thereafter the program increases by 1% annually	Use Case 3 a assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 3a assumptions	Use Case 1b assumptions
Variable Demand Reduction Programs - Rest of WECC	Assume no incremental VDR programs	Use Case 1 Assumptions	Assume rest of WECC achieves reductions equal to 50% of the per capita impacts of California programs	Use Case 1 assumptions	Assume that the rest of the WECC adopts 50% of the per capita reduction that 5000 MW of CA IOU VRD comprises, ramping up from zero as of 2009 and achieving the 50% level by 2015, maintaining it thereafter	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 3b assumptions	Use Case 1 assumptions
Generation Resources									
Existing Generation - California	Use plant list agreed upon by Navigant and Global Energy - joint list to be provided to CEC staff	Use Case 1 Assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions
Existing Generation - Rest of WECC	Update list from Spring 2006 WECC list	Update list from Spring 2006 WECC list	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions

Alternative Resource Portfolio Cases (note Additional Cases 7a and b to be added for aged generation retirements and transmission additions cases)

Scenario Componen, Factor, Assumption	**Case 1**	**Case 1 b**	**Case 2**	**Case 3a**	**Case 3b**	**Case 4a**	**Case 4b**	**Case 5**	**Case 6a/b**
Characterization of Case	**Current Conditions -**	**Modified Current Conditions Case to Reflect Renewable Additions the California LSEs Propose to the CEC in Upcoming Proceeding and Assume Other WECC States Meet Respective Current RPS Goals**	**Current Conditions & "Super High" Gas Prices** ***(Note: this case will get reviewed further after gas forecast assumptions are developed by separate team)***	**High Energy Efficiency and Variable Demand Reduction in Calif Only (Case 1 Mod by EE and VRD)**	**High Energy Efficiency and Variable Demand Response Westwide**	**High Renewables in California (in-state installation) w/ required associated transmission additions**	**High Westwide Renewables w/ required associated transmission additions (do not limit CA renewables to in-state only)**	**Westwide Maximized Preferred Resources (Energy Efficiency and Renewables - Combination of Case 3b and 4b assumptions)**	**Accelerated Retirement/replacement of Aged Generation (Note, a case 6b may be developed if the aged generation that is retired is deemed able to be replaced w/ a meaningful amount of renewable resources in constrained load pockets)**
Retirements - California	Working from CEC's past aged generation list, make specific assumptions	Adjust only if LSEs suggest changes in LTPP filing w/ CPUC or IEPR filing w/ CEC	Assume accelerated retirement of those generating units that are determined to be able to be retired only via repowering from separate Aged Generation and Transmission upgrade case -exact plants and timing to follow from separate study	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 6b assumptions, if that case is undertaken - maximizing renewables to replace retired generation where possible	Use Case 6a assumptions	Use Case 6a assumptions	Achieve the maximum level of retirements that can be accomplished first by transmission, and then by generation additions away from current critical location-sited generation, and then through repowering of those critically located plants that are least efficient and use once-through cooling
Retirements - Rest of WECC	Use WECC spring 2006 list	Use WECC spring 2006 list	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions	Use Case 1 assumptions
Non-Renewable Additions - in California	Assume installation of projects that have IOU recent procurement approvals, projects well advanced in CEC AFC process, and others in logically located areas that have gone through interconnection study - list to be agreed upon between NCI, Global and CEC staff. Beyond time of planned specific additions, after addition of renewables at base case levels, install in-state CCCT and CT plants to meet Resource Adequacy targets (will result in mainly	Adjust only if LSEs suggest changes as a result of higher renewable commitment reducing the level of non-renewable additions required for resource adequacy, or changing the energy requirements to reflect different need in mix of CCCTs and CTs	After presently planned CCCT and CT units, energy efficiency, VRD, renewables, and repowering of aged units associated w/ this Case 2, add new CCCTs and CTs to meet target reserve margins and LCR requirements	Modify Case 1 after consideration of additional energy and peak reductions from high energy efficiency and VRD peak reductions - Global and Navigant need to coordinate to determine what level of distributed generation/combined heat & power will be assumed.	Modify Case 1 to reflect higher renewable additions	Modify Case 1 to reflect higher level of renewables for implications of need for incremental resources to meet capacity margins and Local Capacity Requirements	Use Case 4a assumptions, unless analysis shows that with moving some renewables to out of state requirements more in-state non-renewable capacity for grid reliability	Modify resource needs for Case 3a energy efficiency and Case 4b renewables and then add non-renewable resources required to achieve capacity margin/resource adequacy requirements	Modify case 1 b to achieve the resource additions needed after the retirements assumed in this Case 6
Renewable Additions - California	Use Global Energy's assumed additions of 1600 MW of wind, assuming 31% capacity factor. Global Energy will back calculate what % this is of resource portfolio to enable comparison to RPS target, reflecting this addition to the current base of renewables by year and by GWh and %.	Use IOUs' LTPP filings: SDG&E 12/06 renewables LTPP filing - assume meeting 19% by 2010, 20% by 2011, growing to 30% by 2020), PG&E, assume 19% by 2010 and 20% by 2011, then linear ramp to 25% by 2016, level at 25% from 2016 to 2020. SCE assumes 20% by 2009 using CEC load scenario growing to 26% by 2016. Assume maintaining 2016 % level for 2017 to 2020	Assume same as Case 1 through 2009, then assume linear ramp up for IOUs to 33% by 2020 and linear ramp up for muni utilities to 25% by 2020, where the target levels are after adjustment for Energy Efficiency	Use Case 1 assuptions, but test to see if high EE results in excess energy problem at 20%, due to high EE levels	Modify Case 1 to reflect energy efficiency additions	Assume 33% RPS is achieved by 2020 for IOUs and POUs using linear ramp from Case 1b levels as of end of 2008 up to 2020. Assume all additions are developed in-state.	Use Case 4a assumptions for level of renewables, but modify NP-15 renewables to assume some imported renewables if meeting RPS from in-state only creates significant south to north Calif transmission constraints to move wind or concentrating solar from SP-15 to NP-15	Use Case 4b assumptions	Use Case 1 b, and for Case 6b, assume Case 5, w/ addition of renewables to replace Case 6 renewables if viable from system perspective
End-User Solar PV Assumptions	Assume any PV penetration that was already planned is reflected in the base load forecast	Use IOU-provided PV penetration estimates in 2006 LTPP (need to confirm estimates from PG&E and SDG&E)	Use the greater of LSE's Dec 2006 LTPP or 50% of end-user PV target levels in the California Solar Initiative	Use Case 2 assumptions	Use Case 2 assumptions	Assume that the CSI goals are met (3000 MW of household and commercial PV) and after CSI final target year, assume that the rate of additions annually thereafter are at an incremental consistent with high penetration in new housing development. Estimate other state's penetrations.	Same as 4a for California, and estimate other state's penetrations to be the greater of each state's RPS standards for solar, where applicable, or at a percentage equal to 50% of California's present CSI PV target standards (as percentage of energy) with any resultant solar % above state RPS starting in 2009, ramping up to the 50% of CA CSI level by 2016**[**	Same as 4b	Use Case 1b assumptions for case 6 and Case 4b for Case 6b

Alternative Resource Portfolio Cases (note Additional Cases 7a and b to be added for aged generation retirements and transmission additions cases)									
Scenario Componen, Factor, Assumption	**Case 1**	**Case 1 b**	**Case 2**	**Case 3a**	**Case 3b**	**Case 4a**	**Case 4b**	**Case 5**	**Case 6a/b**
Characterization of Case	**Current Conditions -**	**Modified Current Conditions Case to Reflect Renewable Additions the California LSEs Propose to the CEC in Upcoming Proceeding and Assume Other WECC States Meet Respective Current RPS Goals**	**Current Conditions & "Super High" Gas Prices (*Note: this case will get reviewed further after gas forecast assumptions are developed by separate team)***	**High Energy Efficiency and Variable Demand Reduction in Calif Only (Case 1 Mod by EE and VRD)**	**High Energy Efficiency and Variable Demand Response Westwide**	**High Renewables in California (in-state installation) w/ required associated transmission additions**	**High Westwide Renewables w/ required associated transmission additions (do not limit CA renewables to in-state only)**	**Westwide Maximized Preferred Resources (Energy Efficiency and Renewables - Combination of Case 3b and 4b assumptions)**	**Accelerated Retirement/replacement of Aged Generation (Note, a case 6b may be developed if the aged generation that is retired is deemed able to be replaced w/ a meaningful amount of renewable resources in constrained load pockets)**
Non-Renewable Additions - Rest of WECC	Navigant to review Global Energy's list of additions and compare to WECC spring 2006 list of planned future units, and assume the rest of the base-load needs with CCCTs and conventional coal plants based on economic performance of additions and judgment of locations where coal units are most likely to be added (results generally in 75/25 CCCT/Coal), and fill in with CTs as needed to meet 15% capacity reserve margin	Use Case 1 assumptions	Same as Case 1, except after 2015, 50% of CCCTs that are added in Case 1 are now IGCC units - need to look at out of Calif transmission to see if more Rocky Mountain to west coast transmission capability is needed for this higher IGCC case	Use Case 1 additions	Modify Case 1 to reflect energy efficiency additions	Use Case 1b additions	Modify Case 1b additions for level of renewable additions in rest of WECC	Starting w/ Case 3b resources, modify for Case 4b renewable additions	Use Case 1b and for Case 6b, use Case 5 assumptions
Renewable Additions - Rest of WECC	Assume the announced renewable additions are added, no others. Use WECC-wide wind data that is available from NREL, use monthly shape for the one year of data, and use CPUC rules/guidance for Resource Adequacy capacity equivalent. Rely upon actual data stochastic analysis to demonstrate any variance of contribution of wind to peak supply.	Assume other WECC states meet current respective state RPS requirements/targets	Assume base case additions through 2009 and then assume all other WECC states adopt at least 15% RPS to be achieved by 2012 and achieve 15% by 2012 with linear ramp up from current levels	Use Case 1 additions	Modify Case 1 to reflect energy efficiency additions	Use Case 1b additions	Use CDEAC task force recommendations resulting in adding 35,500 MW (nameplate) of renewables by 2020 (25,000 MW of wind (w/ dependable capacity of wind = 10% or 2,500 MW), 4,500 MW of biomass, 3,500 MW of geothermal and 2,500 MW of solar). Use level annual ramp rate from 2006 levels in CDEAC to achieve these 2020 levels.	Use Case 4b assumptions,	Use Case 1b and for Case 6b, use Case 5 assumptions
Transmission Upgrades/Additions									
California Transmission	Assume Palo Verde - Devers 2 and associated "down stream" upgrades inside of Lugo are installed, no others	Use Case 1 assumptions, except assume the SCE-proposed Tehachapi upgrade is developed.	Same as base case plus transmission additions to meet NP 15 renewables delivery to PG&E & No Calif munis. Evaluate whether SP 15 utilities can meet 33% target w/o additional CA-SW transmission, if not, then add incremental transmission as needed	Use Case 1 additions	Use Case 1 additions	Case 1b assumptions plus transmission additions where required to deliver high renewable portfolio solely from in-state sources	Case 4a, plus robust inter-regional additions to enable Rocky Mountain state renewable energy imports.	Provide transmission consistent with Case 3b energy efficiency and Case 4b renewables	For Case 6a. use Case 1b, modified by the maximum transmission "replacement" that can be achieved to retire the aged generation. For Case 6b, modify only if replacing retired generation with more renewables implies added transmission changes
Rest of WECC Transmission	Review generation additions (renewable and non-renewable and include transmission necessary to deliver using key path preliminary load flow analysis - NCI and Global to coordinate to determine if Prosym "bubble" transfer limits that need adjusting. Need decision on what to assume about trans upgrades from Rocky Mntn states to CA - whether to include any in Case 1	Use Case 1 assumptions, unless review by Navigant of renewable additions required by state to meet each state's RPS implies transmission upgrades are needed	same as Case 1, plus enough "rest of WECC" transmission to deliver renewables and IGCC assumed in this Case 2 to load centers. Assume some level of transmission upgrade from Rocky Mntns to Calif by 2015	Use Case 1 additions	Use Case 1 additions	Use Case 1b additions	Modify Case 1b additions/upgrades to deliver renewable resources to load centers and assume some level (to be determined after Case 4b resource portfolio is prepared) to California, use RMATS/CDEAC transmission upgrades as guide in developing assumed upgrades, checking w/ subregion transfer capability using load flow analysis at high level.	Provide transmission consistent with Case 3b energy efficiency and Case 4b renewables (to be determined at later time)	For Case 6a, use Case 1b assumptions, and for Case 6b, use Case 5 assumptions